Climate change and infectious diseases

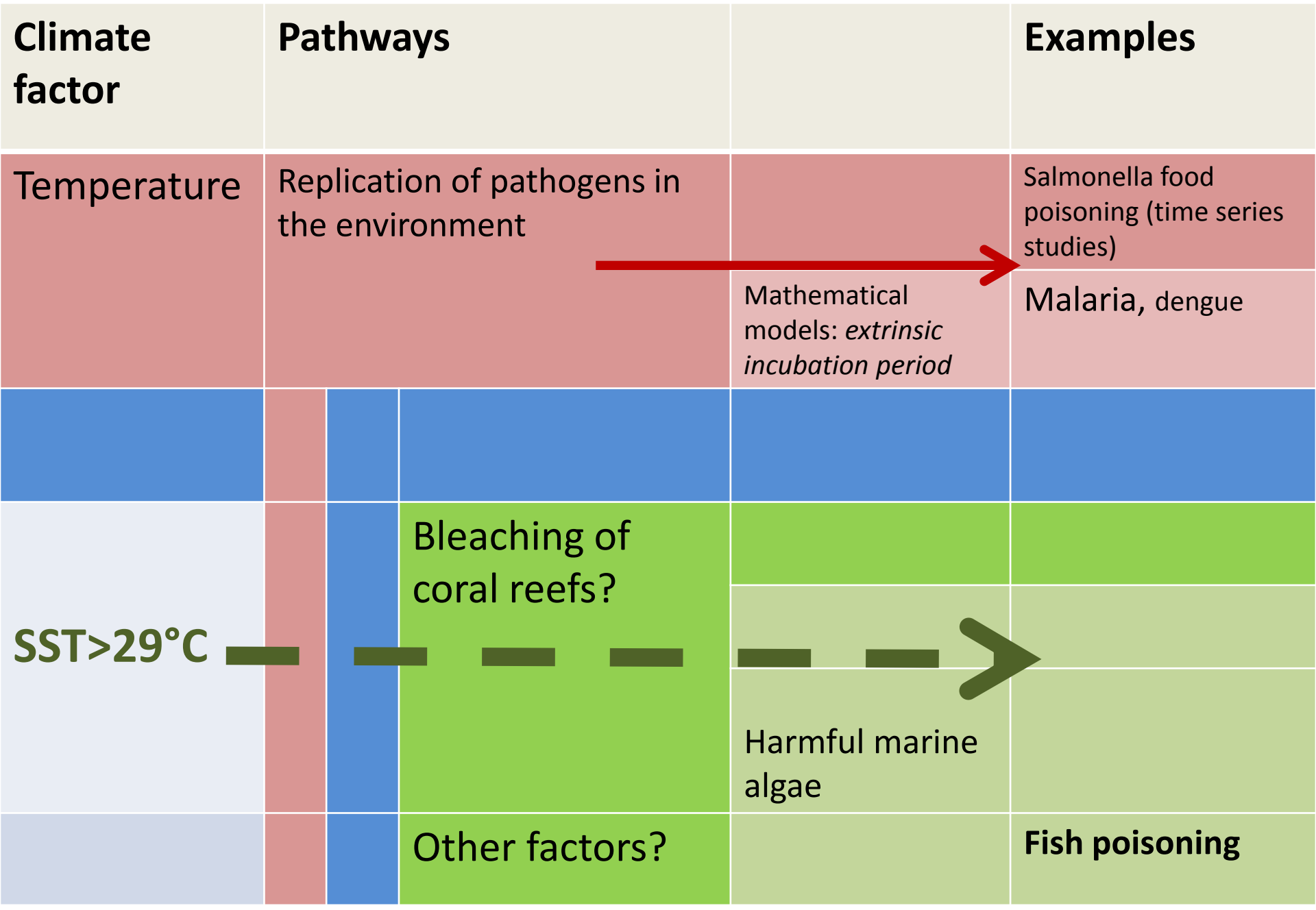
Simon Hales

simon.hales@otago.ac.nz

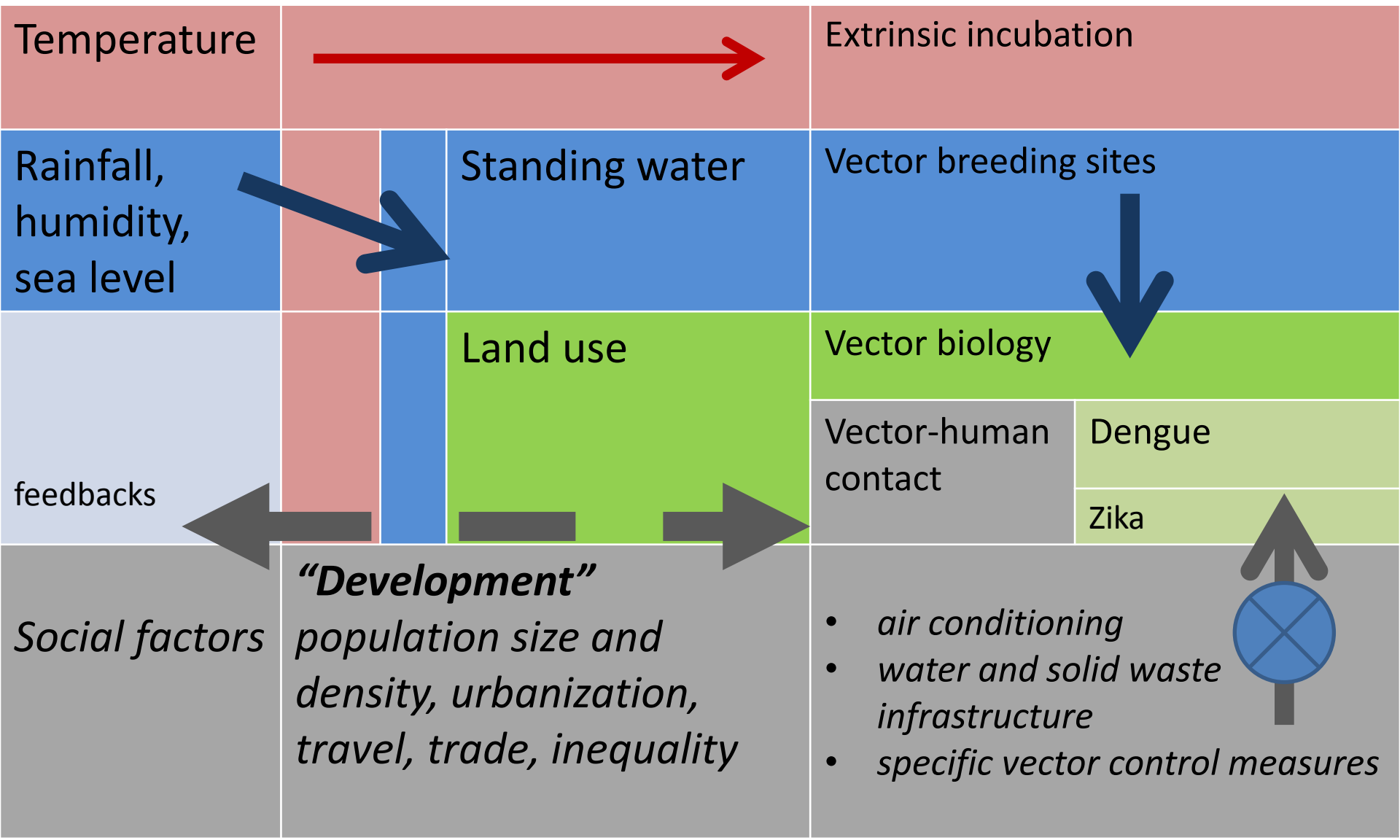
Outline

- Background: climate change and communicable diseases: potential causal pathways, partial understanding of scale and significance
- Modelling climate change impacts on Dengue, Zika
- Conclusions: what do we know?

Climate factor	Pathways				Communicable disease examples
Temperature	Replication of pathogens in the environment				Foodborne infections
					…
Drought and flood			Water safety and availability		**Diarrhoea**
Climate system thresholds			Ecosystem disturbances	Vector distribution and behaviour	Vector-borne diseases
				Intermediate hosts	Zoonoses
					…
			Social impacts:	Loss of livelihoods, conflict, migration	**Poverty-malnutrition-CD interactions**


Climate factor
Pathways
Examples
Temperature
Replication of pathogens in the environment
Salmonella food poisoning (time series studies)
Mathematical models: *extrinsic incubation period*
Malaria, dengue
SST>29°C
Bleaching of coral reefs?
Harmful marine algae
Other factors?
Fish poisoning

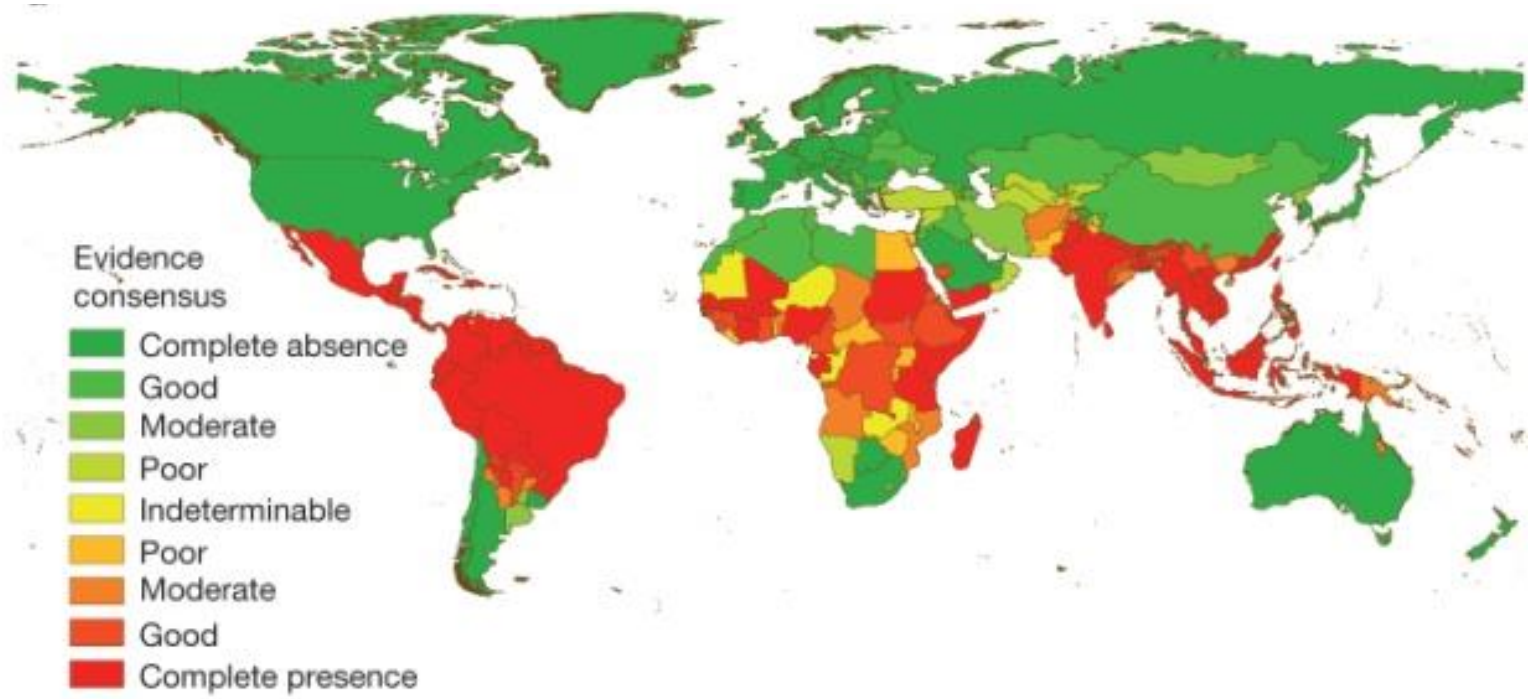
Arboviral diseases

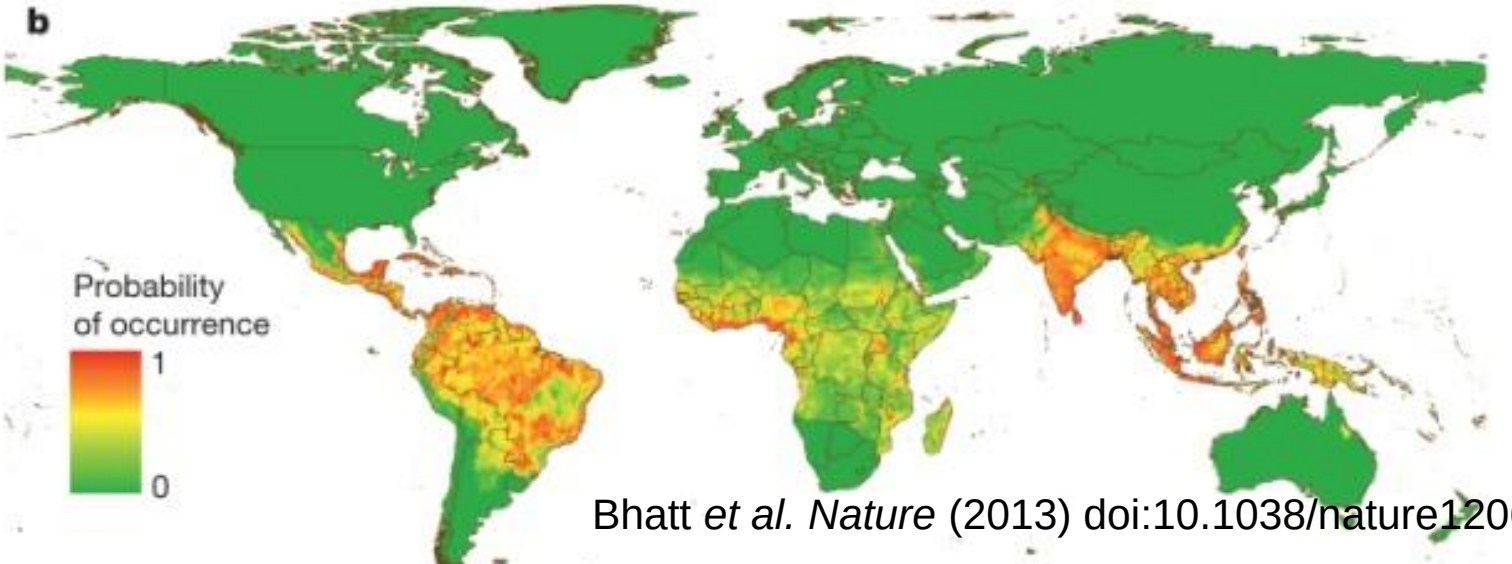


Empirical models for arboviral disease: ecological niche models

- Contemporary global spatial patterns of vector borne disease transmission correlated with climate
- Can include socioeconomic covariates
- Create forecasts (*not predictions*) for future decades, accounting for scenarios of climate change and development

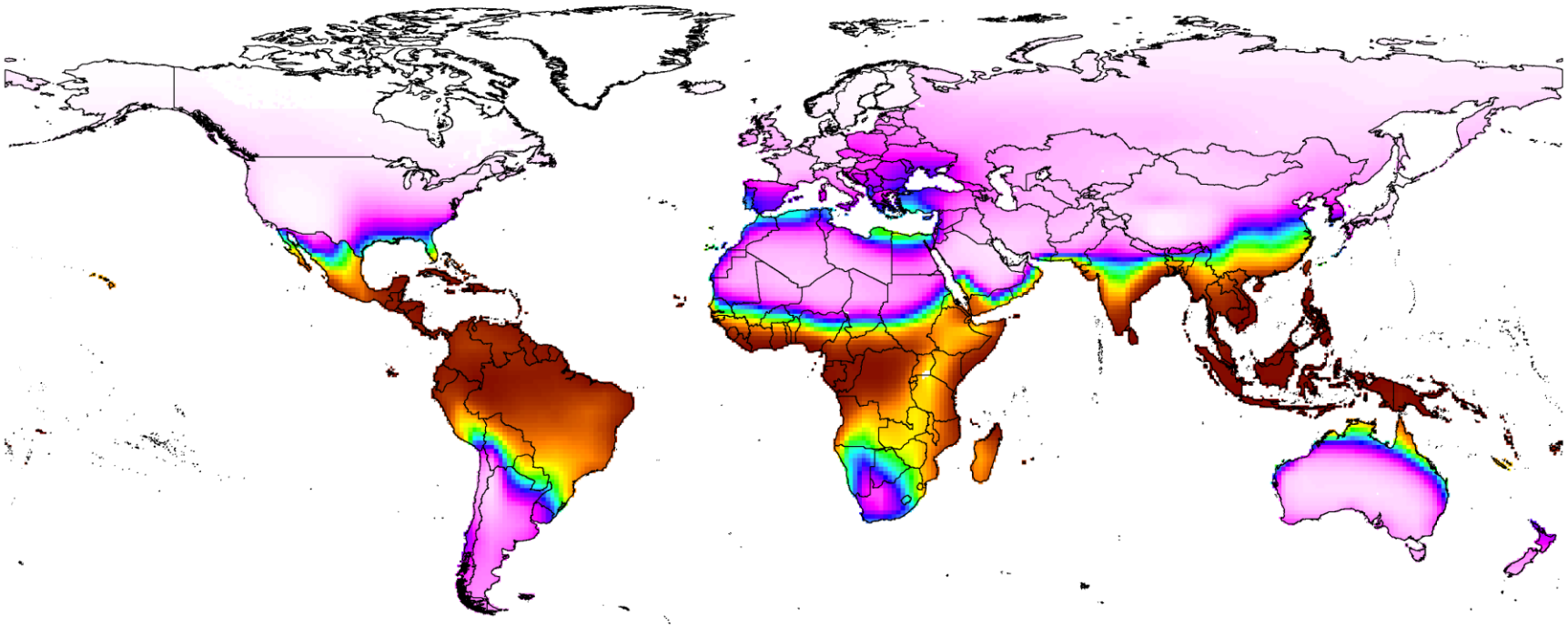
Observed distribution and modelled risk of dengue in 2010





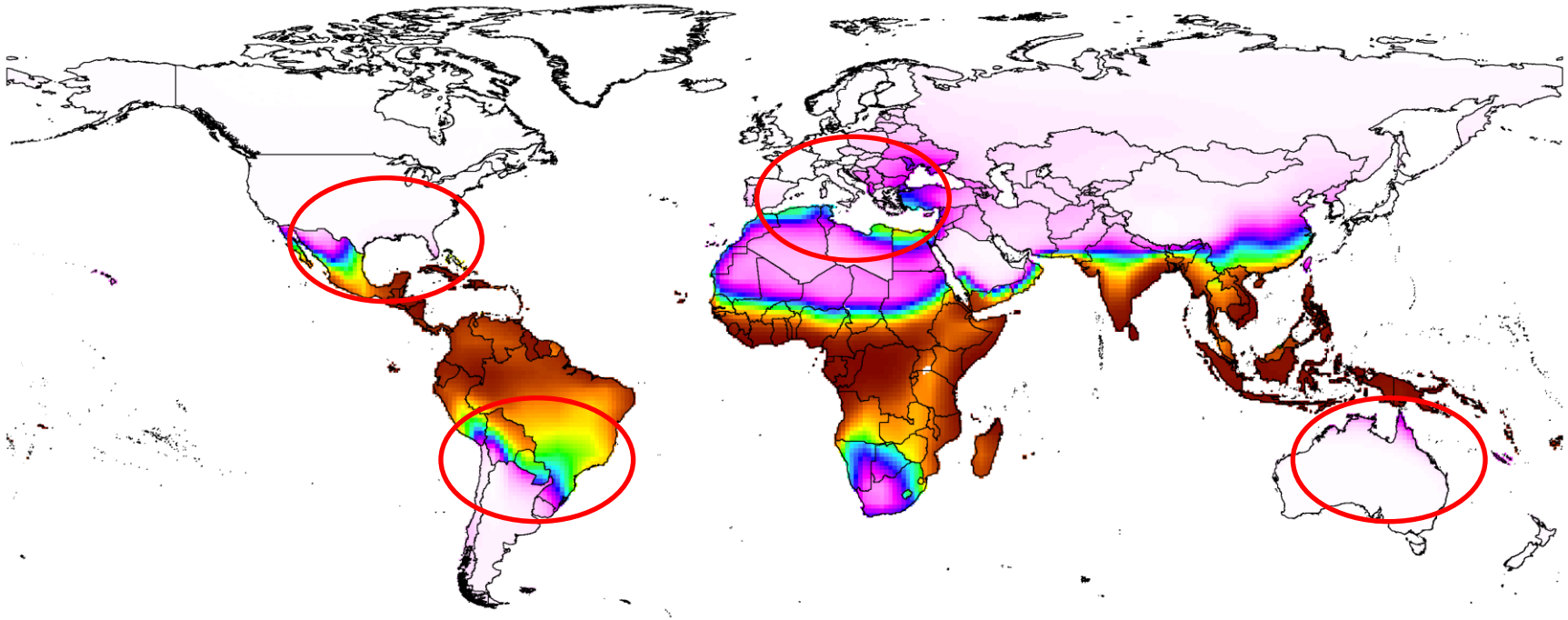
Bhatt *et al. Nature* (2013) doi:10.1038/nature12060

Dengue base model with GDPpc and specific humidity (year 2000)



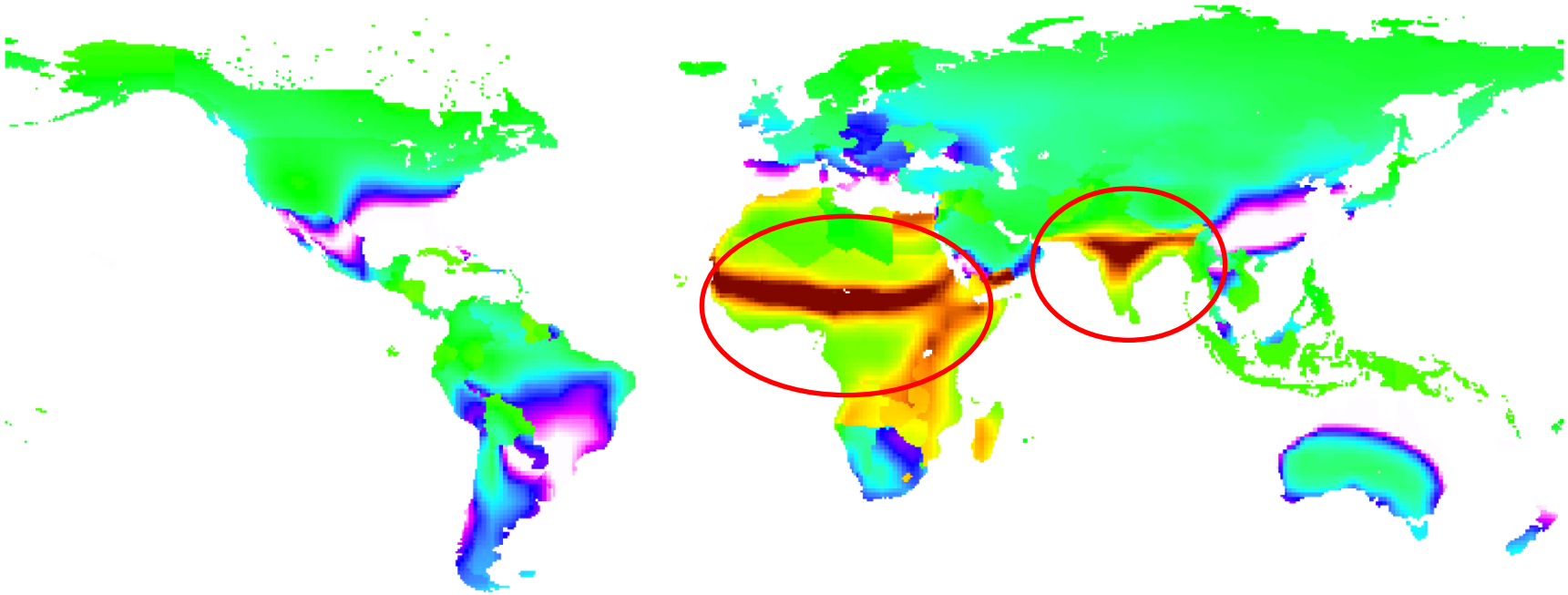
PDEN_BASE
p
High : 1
Low : 0

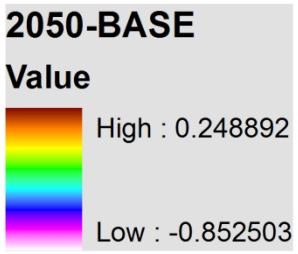
GDPpc OR= 0.9
humidity OR= 1.7



Forecast recession of dengue by 2050s,
despite more favourable climate,
due to assumed socioeconomic development

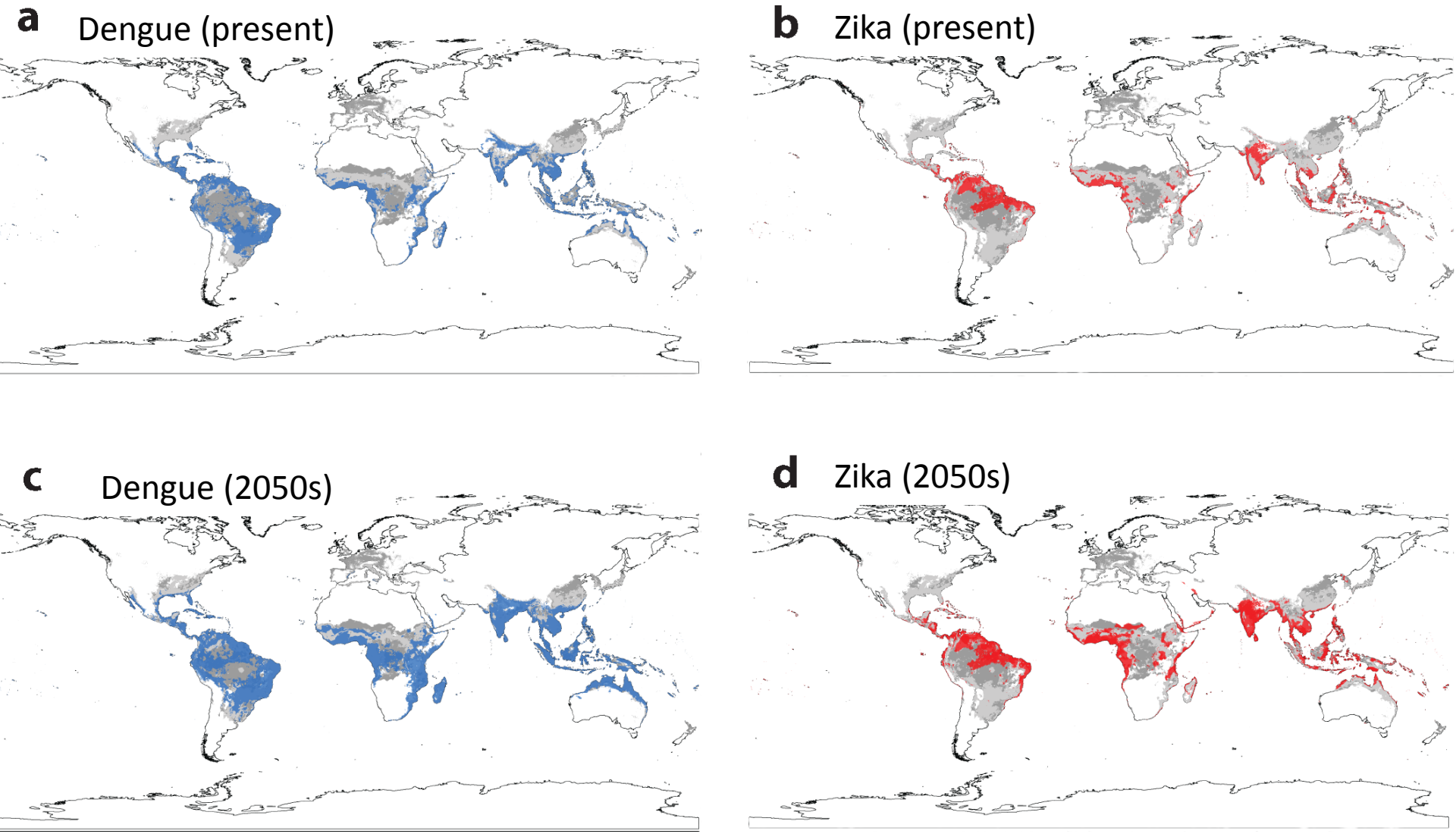
Subtract baseline risk (no CC) from projection with CC: Despite optimistic forecasts of GDP increase in poor countries, projected ~20% increases in risk of dengue



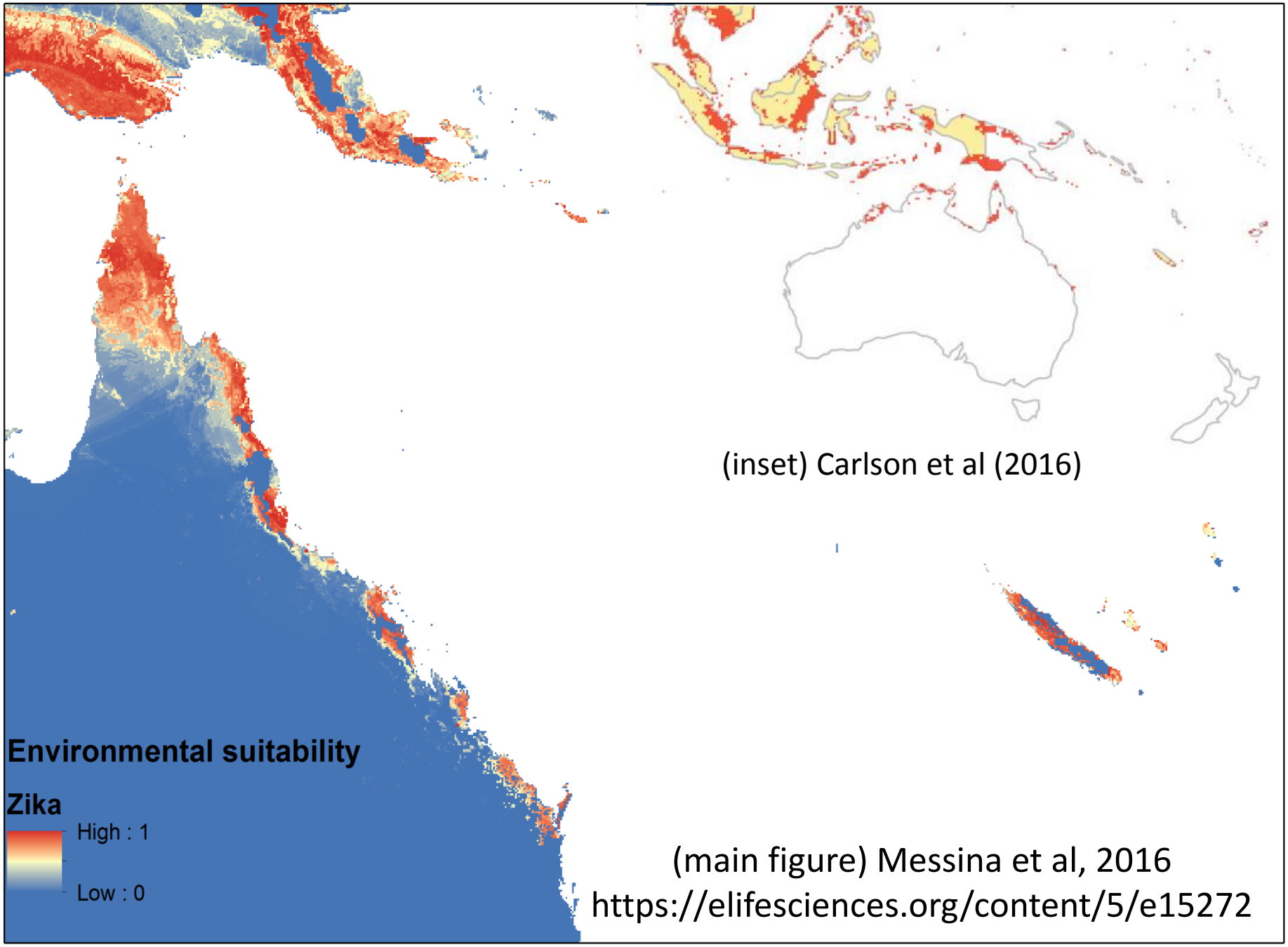


See: Astrom et al, EcoHealth (2013) DOI: 10.1007/s10393-012-0808-0

Effect of CC on dengue and Zika compared



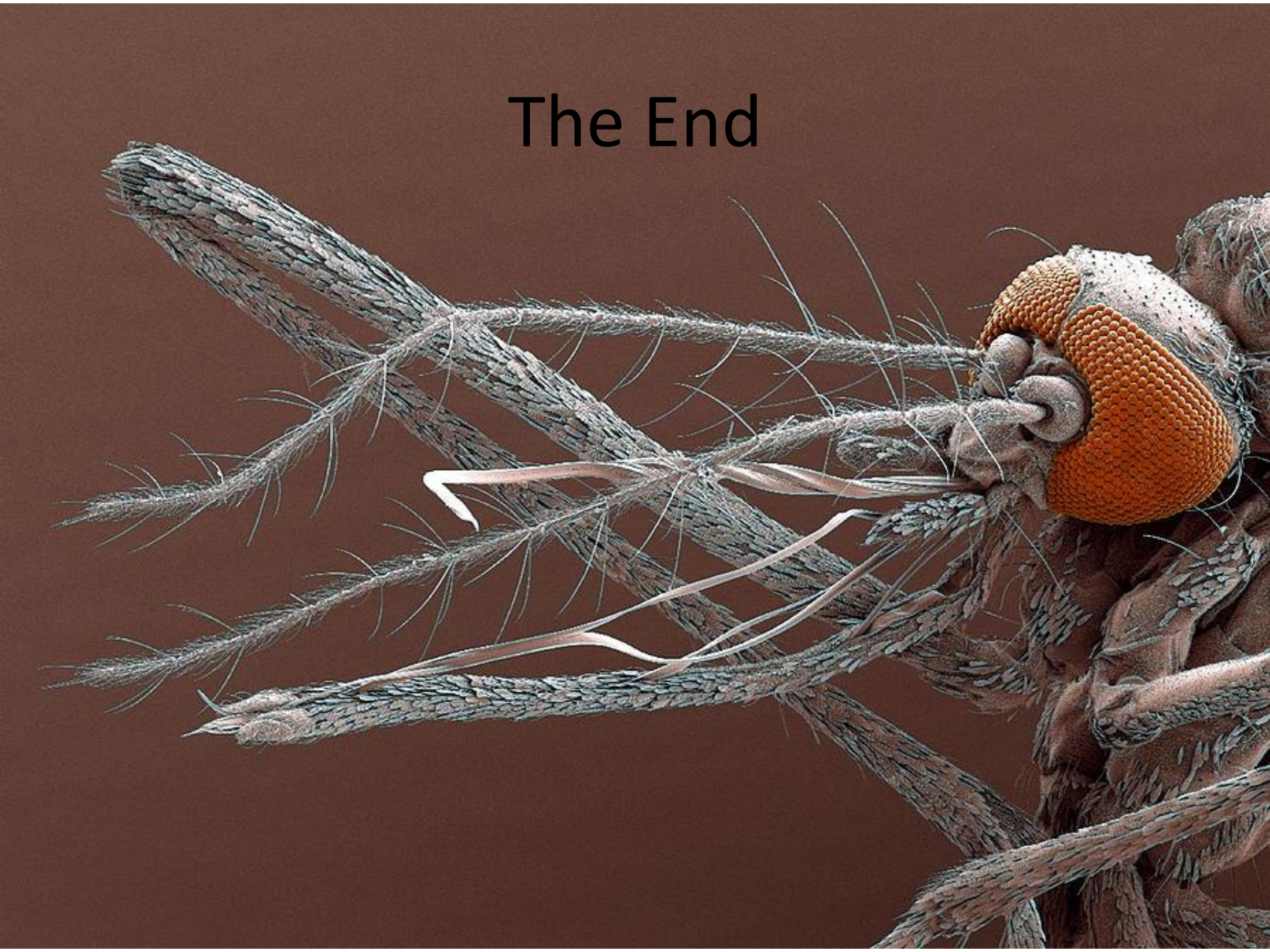
Carlson et al (2016) PLoS Negl Trop Dis doi:10.1371/journal.pntd.0004968


Environmental suitability
Zika
High : 1
Low : 0
(inset) Carlson et al (2016)
(main figure) Messina et al, 2016
https://elifesciences.org/content/5/e15272

Conclusions

- Current empirical models of CC and communicable disease are simplistic
- Climate is an important enabling factor for transmission of many infections
- CC likely to make control of several major communicable diseases more difficult
- Need to incorporate social factors at local scale to make more useful forecasts for policy

The End



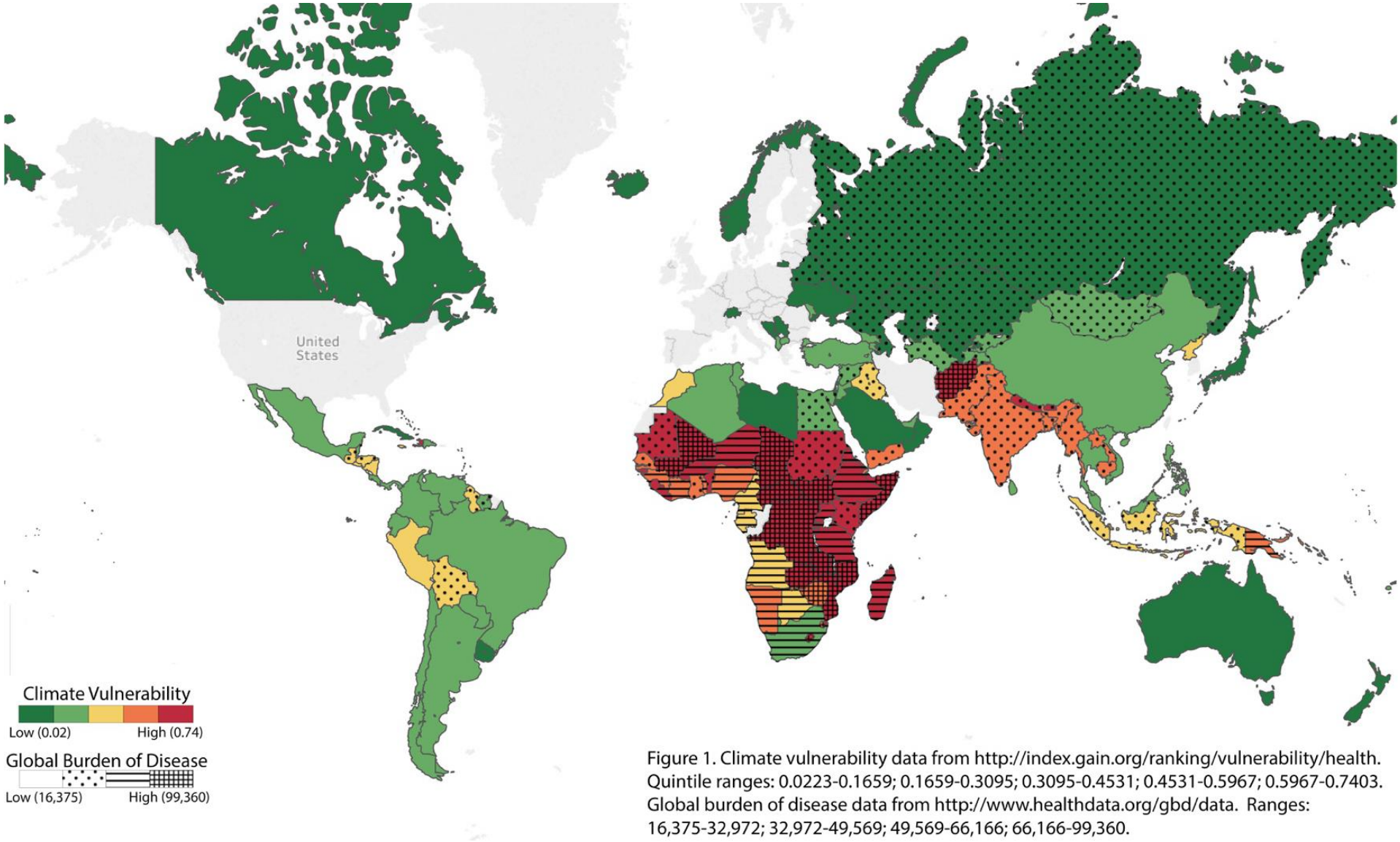
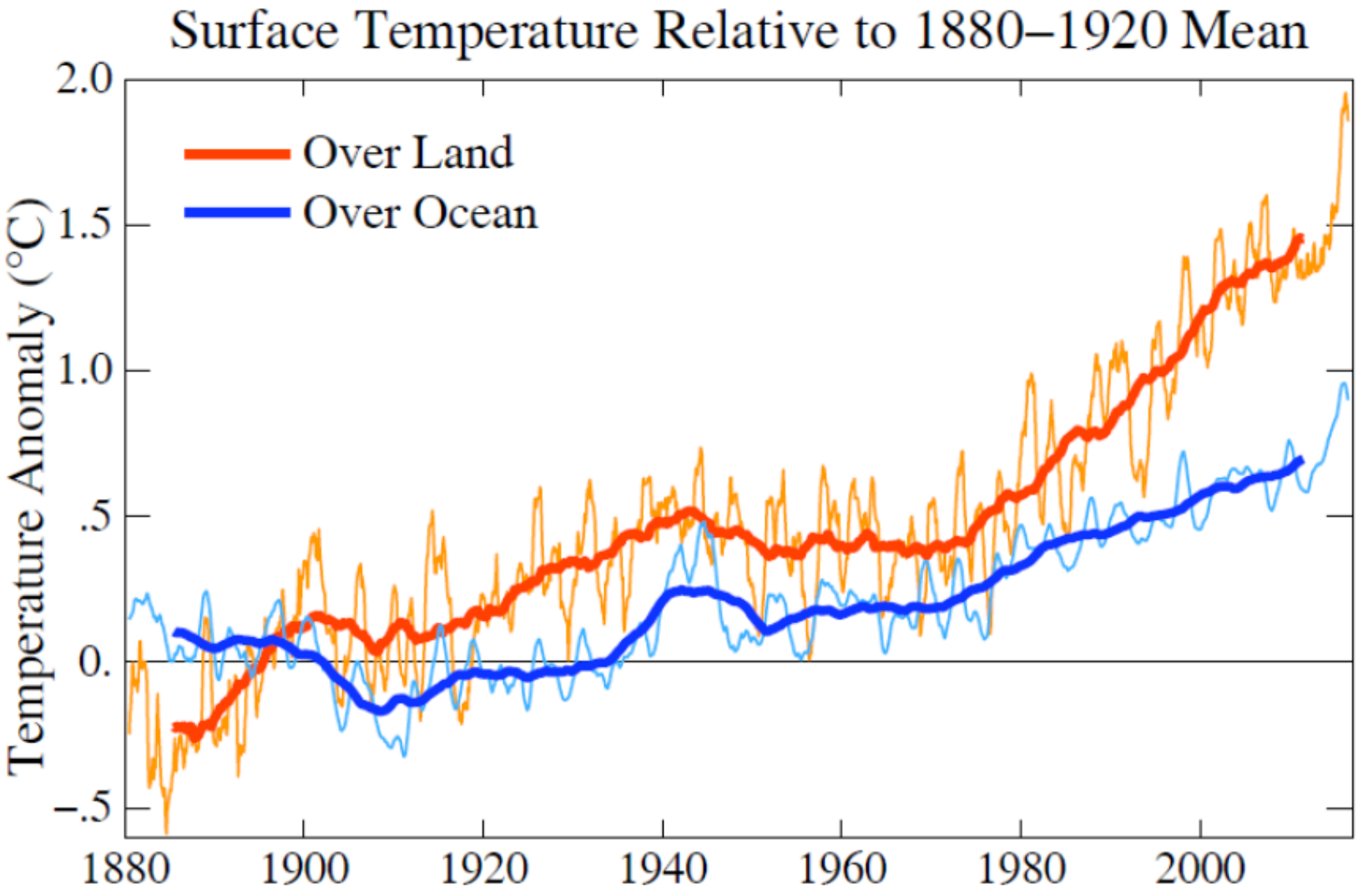


Figure 1. Climate vulnerability data from http://index.gain.org/ranking/vulnerability/health. Quintile ranges: 0.0223-0.1659; 0.1659-0.3095; 0.3095-0.4531; 0.4531-0.5967; 0.5967-0.7403. Global burden of disease data from http://www.healthdata.org/gbd/data. Ranges: 16,375-32,972; 32,972-49,569; 49,569-66,166; 66,166-99,360.

Gupta V, Mason-Sharma A, Caty SN, Kerry V. Adapting global health aid in the face of climate change. Lancet Glob Health 2017; 5: e133–34.


Surface Temperature Relative to 1880–1920 Mean
Over Land
Over Ocean
Temperature Anomaly (°C)
2.0
1.5
1.0
.5
0.
–.5
1880
1900
1920
1940
1960
1980
2000